SNS Commissioning Workshop
Los Alamos National Laboratory
February 15, 2001

Presentations

John Staples LBL Front End Systems

MEBT Diagnostics and Diagnostic Plate application to the RFQ and the MEBT

The MEBT Diagnostics include:

- 6 BPMs for both steering and phase measurements(ToF). These run at the 805 MHz second harmonic to stay clear of contamination from 402.5 MHz from the rebuncher cavities.
- 6 Steering coils linked to the BPMs on 3 rafts, each with ~90 degrees of phase advance. The BPMs are physically in the quads.
- 5 Profile monitors for setting the quads
- 4 RF probes, one in each rebuncher cavity
- 2 Fast toroids capable of resolving the 402.5 MHz RF microstructure of the beam.
- An emittance device to be specified later (slit/collector)

The MEBT Chopper has a 10 nS rise time, so 4-5 RF pulses will be stuck in the turn on/off time. The amplifiers on the toroids have fast, unbuffered outputs which will require 40 MHz digitization that can resolve the 10 MHz rise time. Two channels of fast digitization are a requirement for LBL commissioning. (Action Item 1)

The LEBT chopper risetime spec. is 50 ns but it could be as small as 25 ns.

Tom Shea indicated that the LINAC toroids use the same electronics, without the mux, and will respond at 40-60 MHZ.

Knobs are useful devices in commissioning and we should try to implement them. (Action Item 2)

Should the chopper/anti-chopper run on separate power supplies or should they run off a fixed delay line? There are really no diagnostics to set the chopper/anti-chopper relative timing. John plans to dead-recon from drift times. We will use the BPMs to identify x,x',y,y'. The amplitude differences can be explored with an unpulsed (DC) bias on the plates. We can use a small chopping on/off time to examine the "end effects" of turning the choppers on and off. A single power supply would more likely lead to better

cancellation of chopper effects on the beam such as increased emittance. A second set of chopper power supplies are in the ’02 budget

The MPS must be used to monitor chopper functions or we risk burning out chopper targets (see Action Items 3-4) There are only 2 chopper targets planned. They are expensive and have a long manufacturing lead time. Perhaps we should buy spares (action Item 5)

Recommissioning at ORNL—

Four separate beam dump/instrumentation packages will be used during recommissioning at ORNL on the MEBT, but in the initial commissioning at LBNL they will also be applied to the RFQ.

1) A full power beam dump/Faraday cup with electron suppressor, possibly made by NTG. They are looking into a full power dump which will fit into the anti-chopper slot for Front End studies during DTL installation.
2) An emittance device with a 4 cm vertical aperture, 30 cm of tapered absorber leading to a .002”-.004” slit followed by a 1 m drift and collectors. John estimates 6 Hz – 60 position measurements or 10 sec/measurement. Unfortunately, we will have to break vacuum and rotate the device 90 degrees for the other dimension.
3) Fast Faraday cups for beam bunch structure measurement. Concern was expressed that this measurement cannot be made due to the speed of various systems.
4) A 90 degree delta-P/P spectrometer with double slits for a relative momentum measurement and a measurement of the momentum spread.

During this presentation there was a discussion of the benefits of a gated system to measure discrete time structure components. The general conclusion was that the speed of the transient recorder system will allow us to pick out the time components of interest.

Jim Stovall feels strongly that we ought not wait for “just in time for DTL commissioning” for the in-line emittance measurement devices. We would like to cross-calibrate them with the D-plate in place. (Action Item 6)

Sasha Alexandrov gave a presentation of his predictions of our ability to measure relative phase and amplitude of the beam signals in the BPMs and thereby measure, or set the phase of the rebuncer cavities. Sasha will write this up for distribution. (Action Item 7)

Jim Stovall LANL The Drift Tube Linac

At the end of DTL Tank 1 the D-plate will be used in conjunction with the DTL Tank 1 diagnostics. The D-plate will be used to cross calibrate with the slit and collector in the d-plate.

Pencil beam steering aperture tests will be done in each plane, X and Y with two steering coils in each plane. The pencil beam aperture will be specified by Jim Stovall and built to fit into a wire scanner box in the MEBT. Tom Shea was concerned that the amplitude of the pencil beam would be too low to provide adequate signal to the BPMs. He was assured that one goal of the pencil beam is a beam of about 10 mA peak current. Tom indicated that this is adequate(see Action Item 8).

There was a discussion of the type of slit or aperture appropriate to create the pencil beam. It was suggested that similar slits have been built at LANL and CERN. Information will be gathered on these slit designs (see Action Item 9).

During the discussion of the BPM phase-ToF measurements, Tom Shea indicated that there are 2 RF drivelines and that there are phase instabilities between the two. Tom will investigate the implications of this on the phase difference measurements (see Action Item 10) Jim expressed concern that the D-plate BPMs should have the same spacing as those in DTL Tank 2. LANL will investigate (see Action Item 11)

There were a number of people who made the observation that there appears to be a “distinct lack of software support available for commissioning”, when compared with similar efforts in other laboratories (see Action Item 12)

There was an observation that individual trims will be required on individual magnetic elements, particularly dipoles, run as a “string” on a single power supply. This applies to the ring. (see Action Item 13).

There was a discussion of how to run the D-plate beam dump at higher energy. We must establish a de-rated envelope for the D-plate (see Action Item 14)

In a discussion of the DTL tank commissioning sequence, Tom Shea asked if we really needed to use the D-plate after DTL Tank 3. Jim Stovall noted, with Mike Plum’s agreement that we could use the wire scanners and Faraday cups on each tank and do them in sequence (see Action Item 15)

Jim Stovall and Mike Plum will draw up the commissioning sequence for DTL Tanks 2-6 in the next few weeks and distribute it (see Action Item 16).

LANL accepted responsibility for the specification of the pencil beam dynamics, ORNL took responsibility for the hardware (see Action Item 17)

Jim Stovall feels that we should reexamine the possibility of commissioning the DTL with personnel installing equipment in the tunnel. Some kind of maze and series of locked gates would be required at a minimum. This must be examined in detail with ES&H, Linac operations and others before we considering adopting this policy(see Action Item 18)

Jim Stovall presented the LEDA Commissioning Experimental Plan Sheet. We will adopt something along these lines. Jim will distribute electronic or hard copies to those present. They will mark up their copies and send them to George Dodson. George will assimilate the information, create a Draft SNS Commissioning Experimental Plan Sheet and distribute it for comment(see Action Item 19)

Beam Experiments

A number of beam experiments were proposed for the first round of planning. They are described in the table below. These experiments form the core plan for commissioning. For each experiment, an SNS Experimental Plan must be submitted. The plan contains details of which system is being tested, the beam parameters as well as the diagnostic systems and software that are required. A draft SNS Experimental Plan form is included after the table of experiments.

Table of beam characterization experiments

Measurement	Variables	Operational Diagnostic or Calibration	Specification	Diagnostic
Front End Systems				
LEBT Chopper Risetime			< 50 ns	Fast Toroid in MEBT
MEBT Chopper Risetime	Pulse width 2 Plate pairs timing		< 10 ns	Fast Toroid in MEBT
Emittance of chopped Beam	Chopper transition Duty factor			D-plate slit/collector

Emittance	All possible	MEBT Emittance		D-plate slit/collector
Beam bunch Shape	Rebuncher 4 phases Amplitude 5 setpoints			Fast Faraday cup
Beam delta P/P	Rebuncher 4 phases Amplitude 5 setpoints			spectrometer slits

DTL Systems

Emittance	MEBT match Rebuncher parameters	Wire scanner		D-plate slit/collector
Acceptance	Steering	Wire scanner Toroids		Faraday cup
Phase Scan I	Phase and amplitude	BPMs	1%, 1^{o}	BPMs,D-plate
Phase Scan II	Current,phase	Calibrated absorber Collimator	1%, 1^{o}	pencil beam
Steering	MEBT steering	BPMs		pencil beam
Energy (absolute)	Phase and amplitude	BPMs		ToF
Beam current peak and average			1%	Faraday Cup Toroid

DRAFT- For Comment
SNS DTL Commissioning Experimental Plan

Title: Type II Phase Scan at low current

Objective Measure transmission through tank 1 as a function of rf phase and field amplitude using a pencil beam.

Prerequisites: Pencil beam fully characterized, tank 1 conditioned, MEBT tuned to nominal values for a 10 mA pencil beam

Injector Beam **:** full beam apertured in the MEBT to deliver:

I_{peak}	**:** 10	mA nom
t	**:** 100	μsec
PRF	**:** 10	HZ
$P_{beam,ave}$	**:** 25	W, (75 W accel.)

MEBT

Steering	**:** nom
Focusing	**:** nom
Bunchers	: nom

Choppers

LEBT	**:** off
MEBT	**:** off

RF

t	**:** 200	μsec
PRF	**:** 10	HZ
E_{peak}	**:** 80 - 110 % nom.	

Diagnostics

MEBT	**:** I_{beam}
D-Plate	**:** I_{beam}, profile, absorber, Faraday cup

Control Variables

Rf phase & amplitude

Dependent Variables

Absorber current

Transmitted current

Controls requirements

Control	**:** knob control of tank 1 phase & amplitude set-points
Plot	**:** I_{out} vs. cavity field
	: cavity field vs. cavity set-point
	: I_{out} vs. phase
	: I_{out} / I_{in} vs. phase
	: I_{in} & I_{out} vs. time (μsec)
Monitor	**:** field flatness, resonance, temperature, Injector parameters, …..

Archive **:** N/A

Supporting Calculations: Parmilla transmission curves for measured input pencil beam

Procedure:

Applications Software:

The following lists were compiled as a suggested starting point for the minimum set of applications software needed for initial commissioning:

Software Toolkit

Tweak Knobs
X vs. Y Plotter
X vs. T Plotter (Strip Chart)
X vs. Y vs. Z (Threshold)
Timing

Application Code Toolkit

Emittance
Emittance with reanalysis (cuts and fits etc)
Acceptance
Acceptance with reanalysis (cuts and fits etc)
Profile
Steering Maps
BPM
Wire Scanner Profile
Save/Restore
Save/Restore with hysteresis loop
Data archiver
Data archiver with replay

Action Items:

1. John Stapes indicated that he needs two channels of fast digitization for Front End commissioning at LBNL for readout of the fast Faraday Cups. (Tom Shea)

2. Mike Oothoudt is running a "knob box" application under EPICS at LANSCE. We should investigate this for SNS commissioning (Coles Sibley)

3. We must monitor the MEBT waveform with windowed comparitors and provide an input to the MPS shutdown circuitry to prevent chopper target burnout in the event of a power supply failure. (Coles Sibley)

4. We must monitor the LEBT waveform and provide an input to the MPS shutdown circuitry in the event of LEBT chopper failure. The shutdown must occur in less than 500 uS. (Coles Sibley)

5. Only 2 chopper targets are planned. Who makes them and how much do additional ones cost (Staples)

6. Tom Shea will reexamine the parallel approach to the development of the on-line emittance measurement apparatus for the MEBT.

7. Sasha Alexandrov will provide a writeup of his analysis of the phase and amplitude correlations in the BPMs as a technique for examining the setpoints of the MEBT rebuncher cavities. (Sasha)

8. Jim Stovall will provide information to BNL and LBNL about the geometry and aperture size for the proposed MEBT collimator which will produce a pencil beam of about 10mA

9. Alternative beam dump materials and geometries will be explored and devices from other laboratories examined to determine if they are applicable at SNS. Jim Stoval will provide information about LANL slits and Eugent Tanke will provide information about CERN slits.

10. Tom Shea will provide a quantitative description of the anticipated relative phase instability of the RF drivelines A and B.

11. Jim Stovall will identify someone at LANL will examine the D-Plate to determine if the placement of the BPMs is the same as in DTL Tank 2

12. There was a discussion of the "distinct lack of software support" that is in the current SNS commissioning plan compared with similar efforts at other laboratories.

13. There was a discussion wherein a number of those present concluded that individual trims will be required on individual magnetic elements, particularly dipoles, run as a "string" on a single power supply. This is due to the dipoles ending up on a different place in the hysteresis curve. This should be examined by the Acceptance group, planned for by the Controls and Power supply group

14. How will we run the beam dump on the D-plate at higher energy? One suggestion is to de-rate the maximum power level allowed (Commissioning power envelope). This will be done by LANL.

15. A suggestion from Tom Shea was to eliminate the stage in commissioning where we had planned to move the D-plate to the end of DTL tank 3 for the commissioning of DTL tanks 1-3. The suggestion was to install and commission DTL tank 1, tank 3 will have already been in place, install tank 2 then commission tanks 2,3,4,5, and 6 in order using the Faraday cups and wire scanners at the end of the DTL tanks only. There was a need expressed by Jim Stovall that an emittance measurement at the end of DTL tank 6 would be important to establish the match to the CCL. LANL will check the placement of the wire scanners and sign off on this technique before we officially change the schedule.

16. Jim Stovall and Mike Plum will write up the commissioning sequence for DTL tanks 2-6 in the next few weeks.

17. For the pencil beam, LANL will be responsible for the dynamics and requirements, ORNL will be responsible for the hardware.

18. Jim Stovall feels that we should reexamine the possibility of commissioning the DTL with personnel installing equipment in the tunnel. Some kind of maze and series of locked gates would be required at a minimum. This must be examined in detail with ES&H, Linac operations and others before we considering adopting this policy. George Dodson will begin this process with Frank Kornegay and Jeff Johnson at ORNL.

19. Jim Stovall presented the LEDA Commissioning Experimental Plan Sheet. We will adopt something along these lines. Jim will distribute electronic or hard copies to those present. They will mark up their copies and send them to George Dodson. George will assimilate the information, create a Draft SNS Commissioning Experimental Plan Sheet and distribute it for comment